

# An instrument for double mirror alignment at ESRF

O.Hignette, Y.Dabin, L.Eybert, N.Levet

*ESRF 6 rue Jules Horowitz BP 220 38043 Grenoble Cedex 09 FRANCE*

## OUTLINE

- Requirements and specifications
- Principles
- Instrument description
- Test results
- Benefits
- Perspectives

## Requirements and specifications

### Requirement

5 UPBL's horizontally reflecting double mirrors systems  
Need for parallelism and gap set up in clean room and on beamlines

### Specifications

- Parallelism accuracy 20  $\mu\text{rd}$  ; gap 30  $\mu\text{m}$
- Metrology accuracy : parallelism 10  $\mu\text{rd}$ ; gap 10  $\mu\text{m}$
- Incidence angle range : 2 mrd- 1.05 ° ; gap 1mm – 35 mm

### Perceived Present Shortcomings

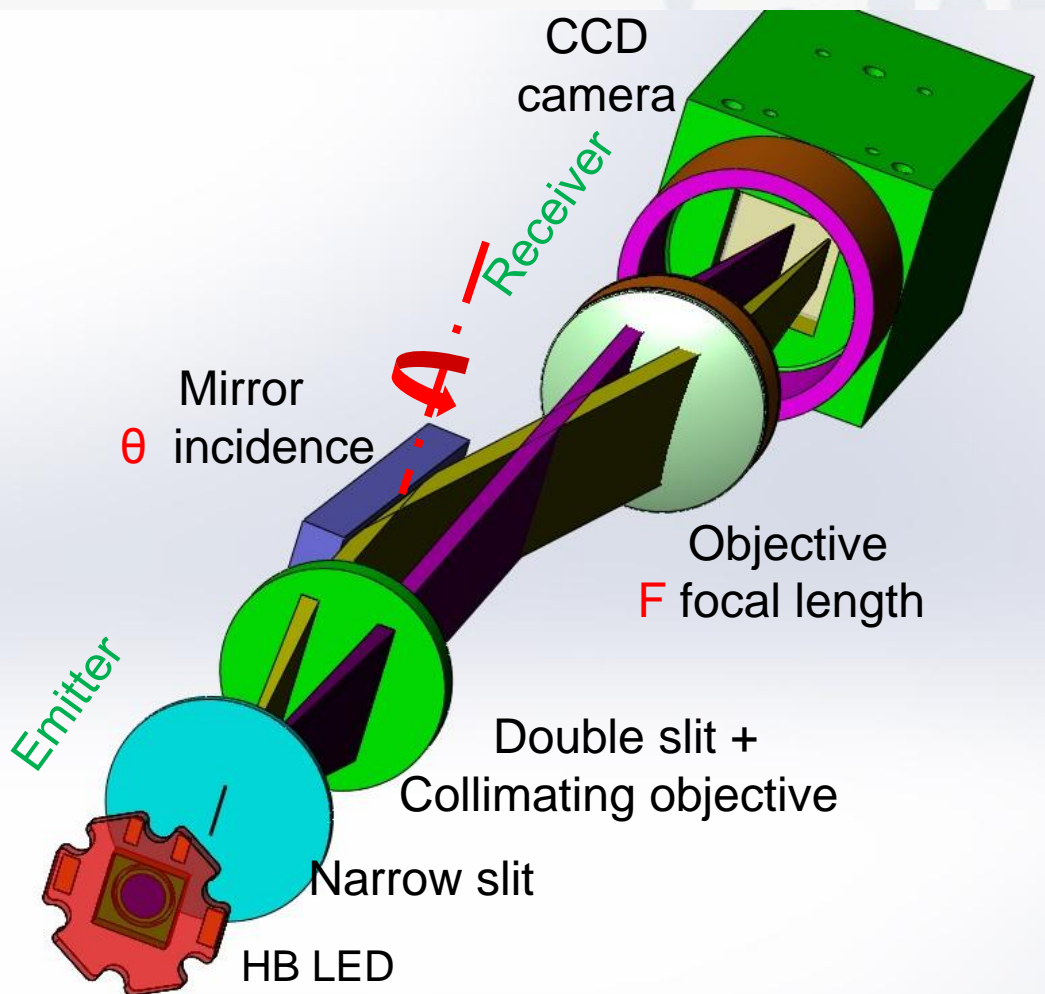
- Accuracy of Survey Group instruments too limited
- 3D Mechanical metrology set up difficult
- On line Beamline check up with clean conditions impossible

### Solution

Design of a dedicated optoelectronics instrument

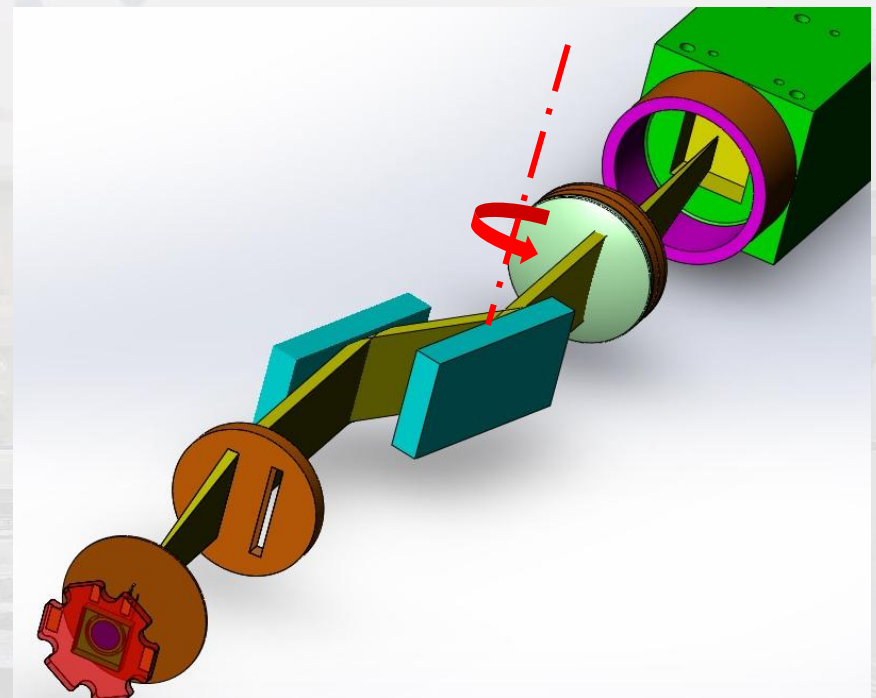
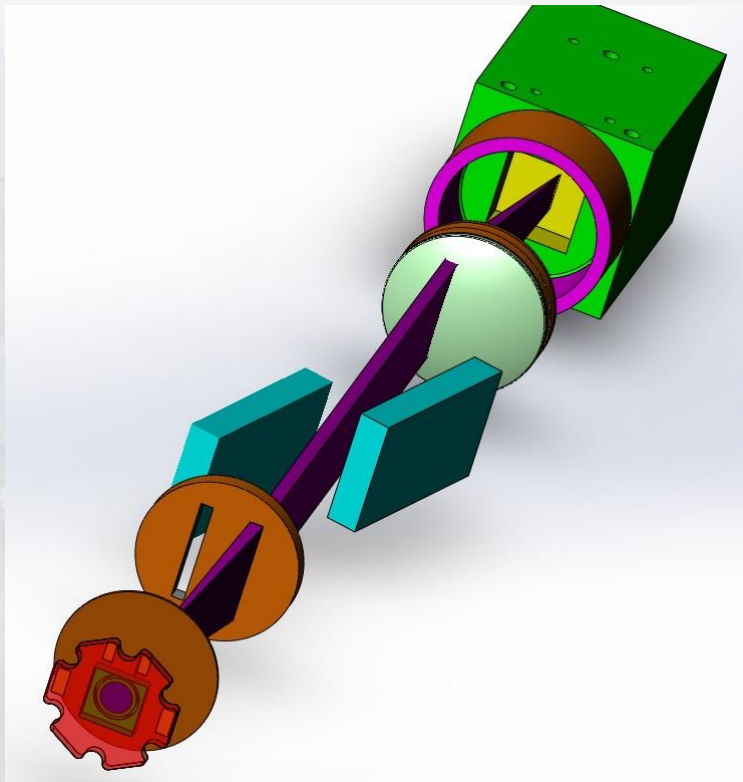
## Principles I

Incidence angle set up : angle metrology with telescope



## Principles II

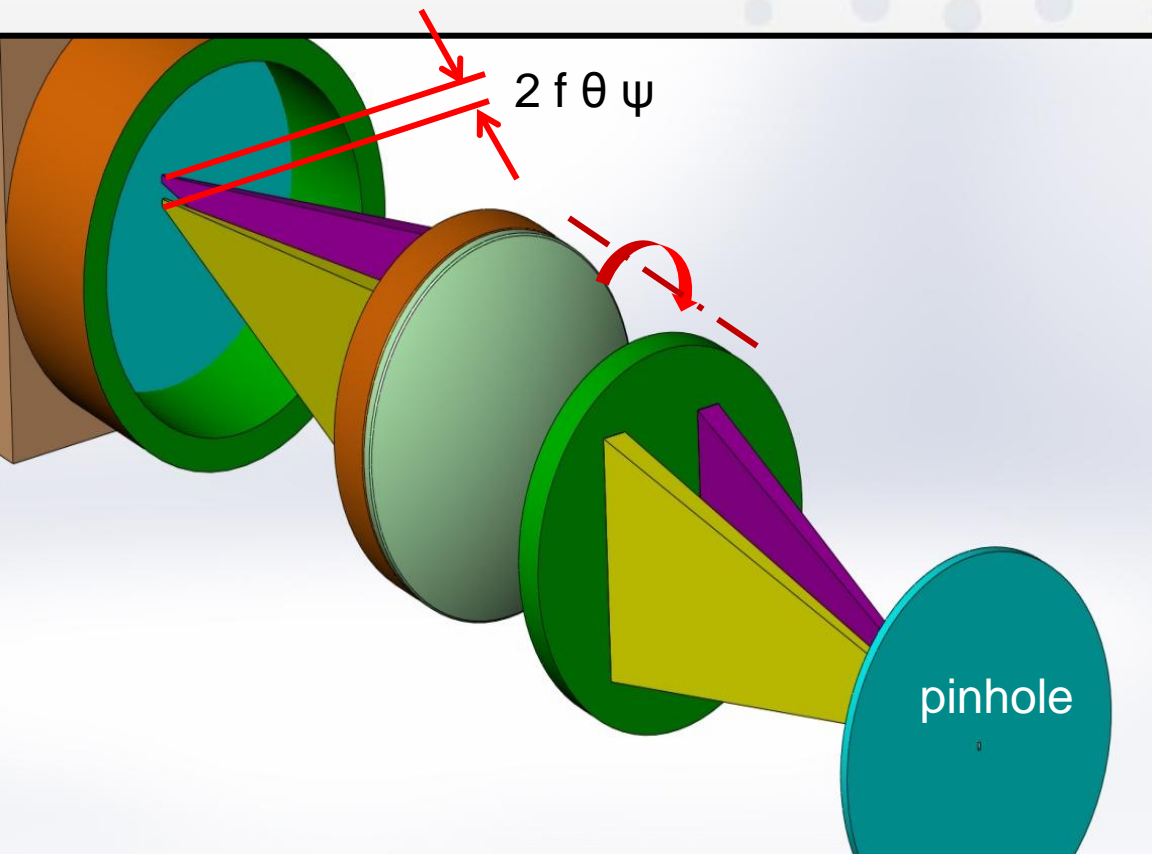
Horizontal plane parallelism set up : angle sensing with telescope



The twice reflected beam is focused on the same location as the direct beam

## Principles III

Parallelism set up : Vertical plane parallelism  $\psi$

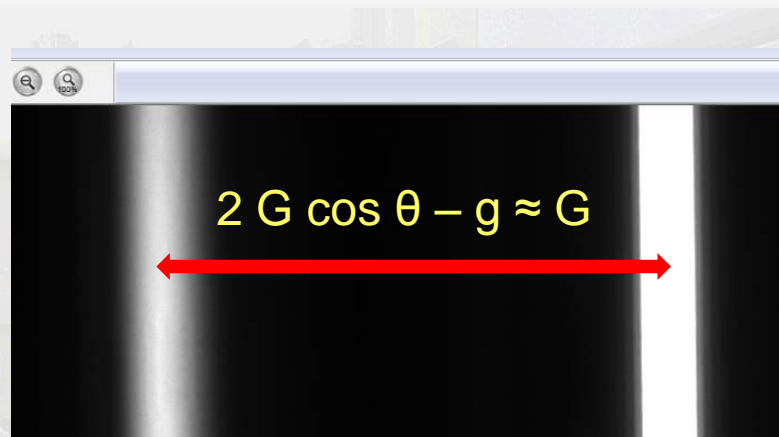
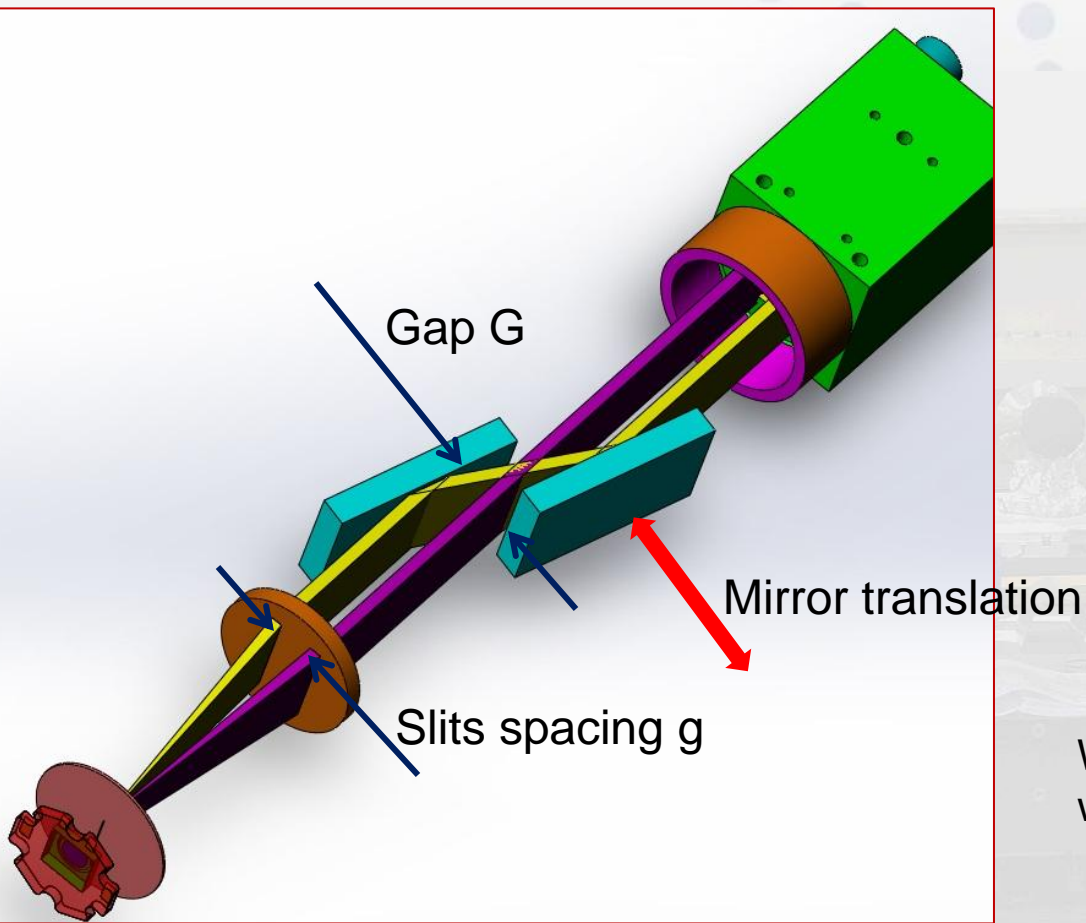


Cancelling the vertical shift by  
Relative mirrors tilt



## Principles IV

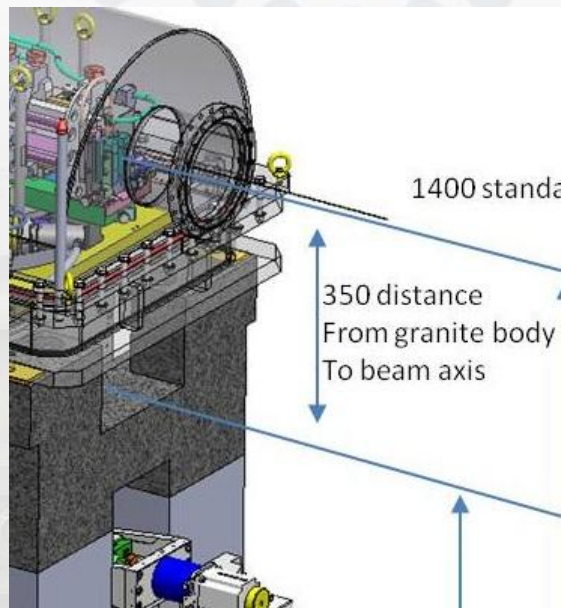
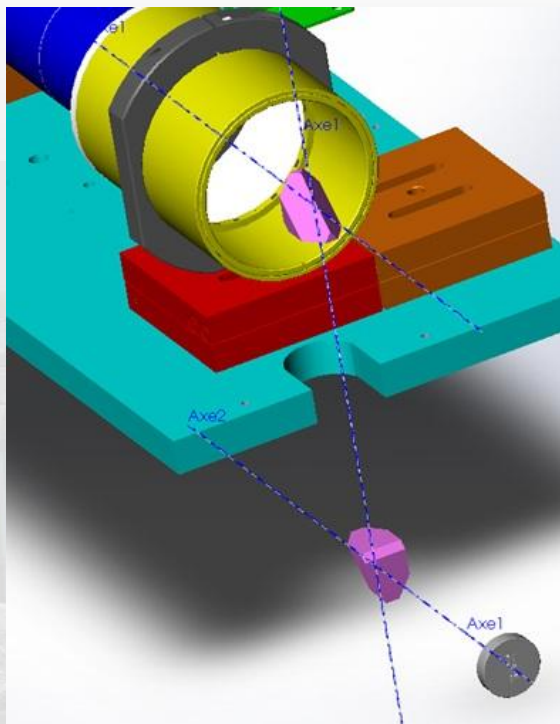
Gap set up : position metrology without Telescope



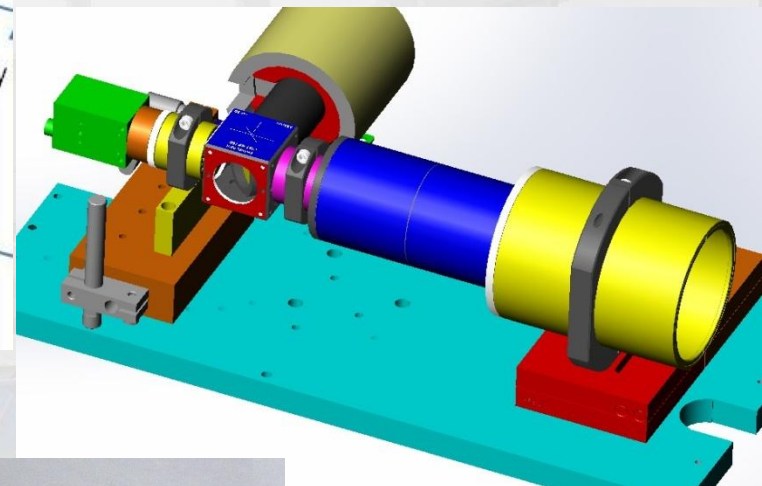
When  $G > 9 \text{ mm} \Rightarrow$  camera translation with linear scale metrology

## Instrument description

Granite / Survey group references / X-Ray Referencing (  $<100 \mu\text{rd}$  )



Autocollimator

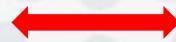
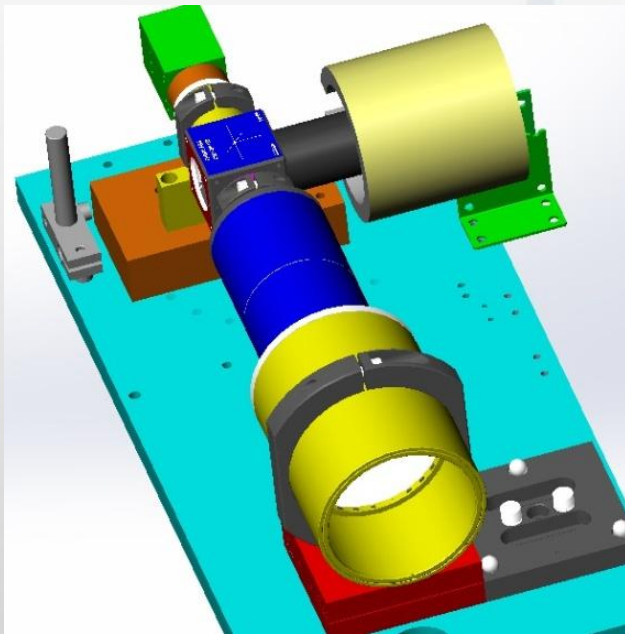


4 Reflections scheme horizontally invariant with Z-axis rotation

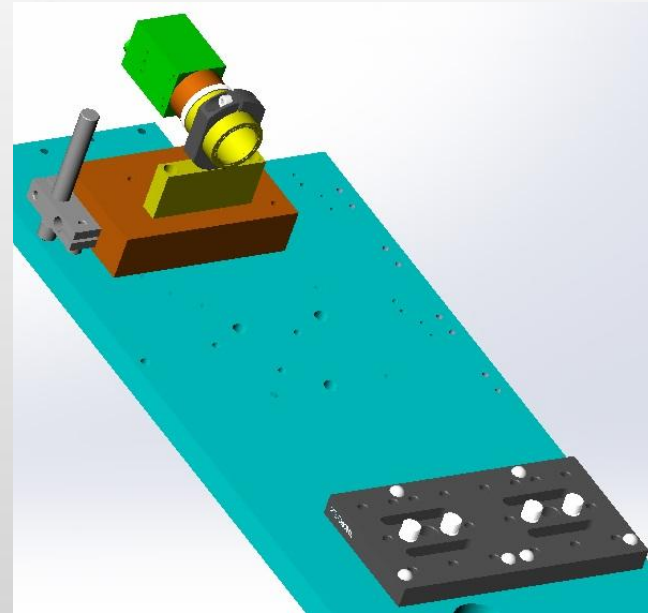
# Instrument description

## Switchings

Angular metrology



Linear metrology



Kinematic support autocollimator placement

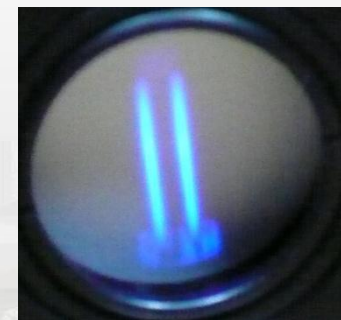


## Instrument description

### Switchings

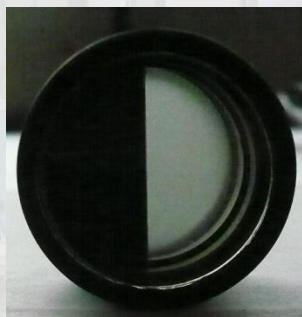
full beam / dual slit beam / single slits beam

Kinematic slits support



Double slit

After 2 meters  
Propagation



Polarization encoded slits

Choice of slit width (blue coherent beam )

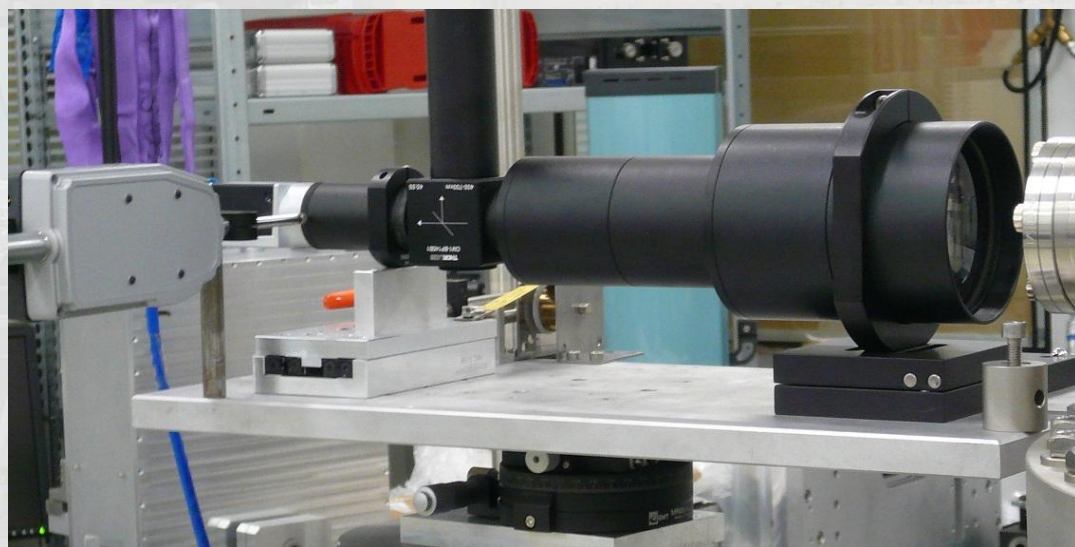
$$\Phi \cong \sqrt{\frac{4\lambda L}{\pi}}$$

$$\lambda = 0.46 \text{ } \mu\text{m}$$

$$L = 2.5 \text{ m}$$

$$\Phi = 0.9 \text{ mm}$$

## Instrument description



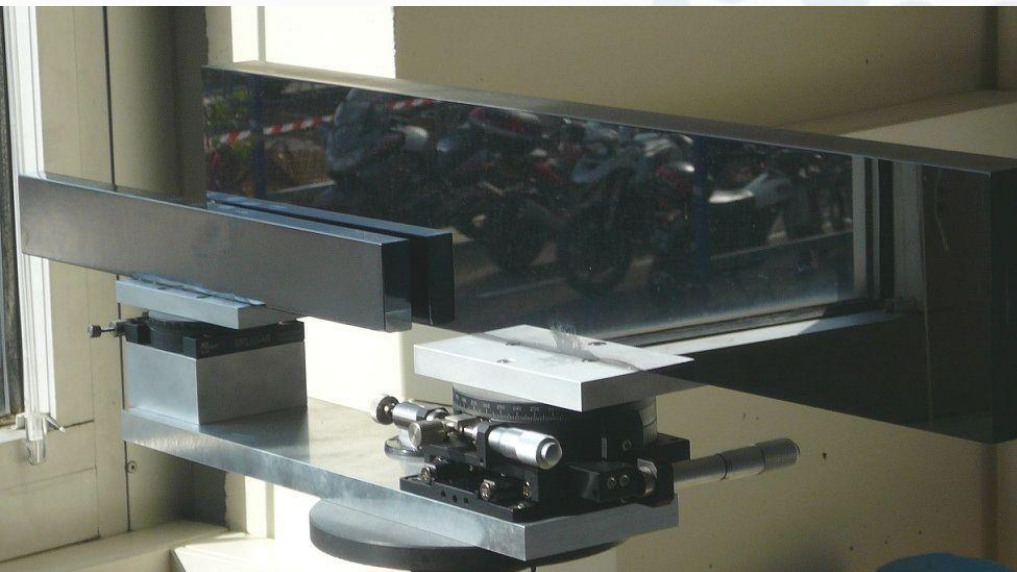
# Instrument description

## Sequences

- Receiver angular alignment to X-Ray ( granite)
- Emitter angular alignment/receiver with large beam
- First mirror angle set up
- Second mirror parallel to first one ( alternating single slits)
- Gap linear alignment ( dual slit )



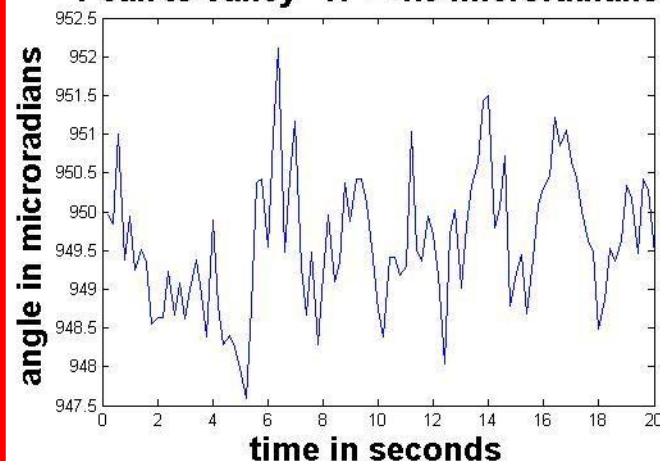
## Test results



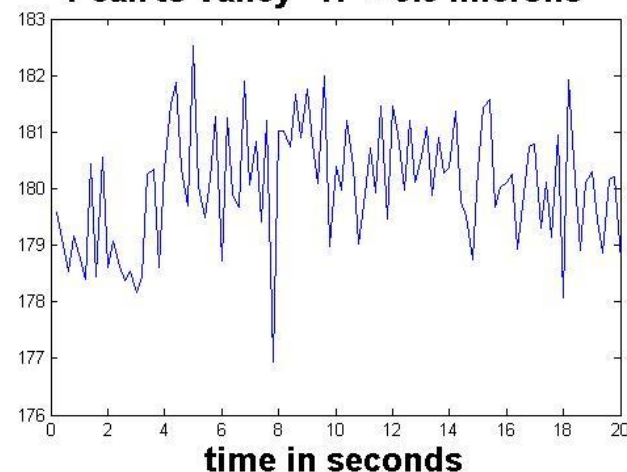
Double mirror system ( 500+300 mm)  
Gap 1.6 mm incidence angle 3 mrd  
Distance emitter receiver : 2.5 m

Limited by turbulences :  
May be improved by averaging

**angle standard deviations  $H = 0.86$  microrad**  
**Peak to valley  $H = 4.5$  microradians**



**gap standard deviations 1.07 microns**  
**Peak to valley  $H = 5.5$  microns**





## Benefits

Systems with all motorized Degrees of Freedom

Limits fine rotation stroke and bellows stroke

Limits X-ray beamtime needed for alignment

Systems with partially motorized Degrees of Freedom

Limits strokes . Allows for non motorized degrees of freedom

Stiffness gain

The instrument may (??) allow for non motorized systems

Stiffness gain and reliability benefits

## *Perspectives*

- Ready to be used in November 2012
- The User interface is being tested
- The Instrument is qualified within specifications
- Usable in the mechanical lab and on beamlines